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Influence of Community Cultural Wealth on Undergraduate Women of Color in Computing

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Abstract

Black and Hispanic women have historically encountered hegemonic structures, implicit biases, and internalized racism associated with deficit mindsets, which have served as barriers contributing to their underrepresentation in U.S. science, technology, engineering, mathematics, and computing (STEM+C) education (Chakraverty, 2022; Jaumont-Pascual et al., 2021). With the apparent marginalization of Black and Hispanic women in the computing workforce, this pilot study focused on the experiences of this population as they persisted in their undergraduate education at a Hispanic-serving institution in Texas. This mixed-methods study employed the ACCYESS STEM+C Majors (ASCM) survey instrument and the ASCM interview protocol to illuminate the modified community cultural wealth (CCW) dimensions and the relevant lived experiences that have influenced undergraduate Black and Hispanic women's enrollment and persistence in K–16 computing education. In this study, we utilize the CCW framework (Yosso, 2005) as a theoretical lens to interpret how Black and Hispanic women promote their strengths to resist forms of systemic and institutionalized racism in computing education, from an anti-deficit approach. Our findings highlight the ways in which CCW factors influenced Black and Hispanic women's choice to pursue and persist in undergraduate computing education in response to our collective need to better support this population in their attainment and representation in STEM+C disciplines.

Keywords: community cultural wealth, Hispanic-serving institution, persistence in STEM+C, undergraduate computing majors, women of color

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Introduction

In the United States, women represent 49% of the overall population (ages 18–24) and 50% of the STEM workforce, but only 15% of the computing (i.e., computer and information sciences) workforce (National Science Foundation, 2019, 2020). Historically underrepresented minority (HURM) women, particularly Black and Hispanic women, represent 16% of the overall U.S. population, yet HURMs women and men combined represent only 16.73% of the STEM workforce and approximately 23% of the computing workforce (National Science Foundation, 2020). While the percentages of Black and Hispanic women in the science, technology, engineering, mathematics, and computing (STEM+C) workforces are unknown, their underrepresentation in these workforces is apparent. Furthermore, Black women, Hispanic women, and other HURMs are underrepresented in U.S. computing education at every postsecondary degree level, particularly at the graduate level (Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline, 2011). Since Black and Hispanic women's underrepresentation in U.S. STEM+C education is largely due to barriers related to hegemonic structures, implicit biases, and internal racism associated with deficit mindsets (e.g., imposter syndrome, implicit biases), this study utilized a modified version of the community cultural wealth (CCW; Ashford-Hanserd et al., 2024; Ashford-Hanserd, 2016) model (Yosso, 2005) as an anti-deficit lens to illuminate how Black and Hispanic women access their strengths to survive, resist forms of oppression, and persist in the STEM+C workforce pipeline.

This study is part of a larger 5-year, longitudinal, mixed-methods investigation examining the effects of CCW on the persistence of Black and Hispanic women in the computing workforce pipeline (grades 8–17) as they matriculate from middle school into high school, into a bachelor's degree program, and into graduate school (i.e., master's or PhD degree) or the computing workforce. The aim of this pilot mixed-methods study was to illuminate the CCW factors and the relevant lived experiences that have influenced Black and Hispanic women's enrollment and persistence in undergraduate computing education. The overarching research question that guided this study was "Which CCW dimensions most influence the enrollment and persistence of Black and Hispanic undergraduate women in comparison to their male counterparts in the computing workforce pipeline at a Hispanic-serving institution (HSI) in Texas?" This study showcased how an anti-deficit lens can assist us in understanding how to best support Black and Hispanic women's persistence in undergraduate computing education.

Conceptual Framework

Community Cultural Wealth

CCW provides a "lens" (Yosso, 2005, p. 77) for viewing communities of color that offers an alternative to traditional definitions of cultural capital. Through CCW, Yosso (2005) began with a foundation in critical race theory and offered that communities of color, through their lived experiences, bring assets easily overlooked in deficit-driven frameworks. Yosso (2005) offered six forms of capital—aspirational, linguistic, familial, social, navigational, and resistant—but recognized that this list is not exhaustive and that these forms of capital are not mutually exclusive and may overlap. To this point, Yosso (2005) referenced Anzaldua's (1987)

application of *mestizaje*, or the ability *and willingness* to create new categories when the old ones do not suffice.

Each of the six forms of cultural capital identified by Yosso (2005) embody assets and resources found in communities of people of color identified in the literature over several decades. *Aspirational capital* values the ability to maintain hopes and dreams despite potential barriers and without previous experiences on which to rely. *Linguistic capital* is defined as the ability to communicate in more than one language or style. This is distinctly different from bilingualism as it is not based solely on languages but rather on one's ability to communicate across cultures and audiences. *Familial capital* encompasses the support, history, and guidance gained through community ties garnered from family, extended relatives or kinship families, and communities of support such as religious groups or schools. Familial capital also captures the importance of giving back to one's community. *Social capital* represents the social networks maintained and community resources available. *Navigational capital* is the form of cultural capital in which people of color "maneuver through social institutions" when they are in racially hostile environments (Yosso, 2005, p. 80). *Resistant capital* is exemplified by people of color through actions and mindsets that challenge the status quo embedded in systemic racism and inequality. In addition to these forms of capital, *spiritual capital* is added to this study as a seventh source that may exist within these other forms of capital or independently to provide individuals with strength and resilience derived from their faith (Ashford-Hanserd, 2021; Park et al., 2020; Pérez Huber, 2009; Yosso, 2005).

Literature Review

To understand how CCW influences the persistence of Black and Hispanic women in their undergraduate computing education, we conducted a review of relevant literature of women in STEM with a specific focus on computing. Particular attention was paid to differential outcomes in the field including the gender gap and then, more specifically, Black and Hispanic women, in line with the theoretical framework's anti-deficit perspective. Our literature review exposed the continued need for research to better understand how to support underrepresented women in STEM, specifically in the field of computing. In addition, to garner an understanding of how CCW may be applied to computing students who identify as Black or Hispanic women, we included literature regarding the persistence of their STEM educational journey utilizing CCW. Hence, we outlined each form of capital included in CCW and the additional spiritual capital to close the literature reviewed.

Underrepresentation of Women in Computing

Gender inequities in STEM, particularly within computing, persist as manifestations of structural exclusion rather than individual underperformance (U.S. Department of Labor, 2021). Despite the widespread framing of these disparities as "gaps," such language often reproduces deficit narratives that obscure the systemic forces shaping women's, particularly Black and Hispanic women's, participation and outcomes (Lord et al., 2015). For example, studies conducted at historically Black colleges and universities attribute differences in preparation to inequitable access to pre-college computing resources as conditions rooted in structural racism and gendered opportunity gaps, not a lack of capability (Buzzetto-More et al., 2010). Similarly, documented differences in retention and graduation rates among Black and Hispanic women

reflect how institutional cultures, curricular norms, and exclusionary pedagogies sustain racialized and gendered hierarchies in computing (Lord et al., 2015)

Alternatively, other research (Bowman et al., 2022; Varma & Hahn, 2007) has begun investigating the differential gender outcomes from a structural perspective, providing viable recommendations to address systemic gender inequalities. Researchers such as Bowman (2022) and Varma and Hahn (2007) have recommended institutions begin by recognizing the negative stigmas and hegemonic narratives against women that are prevalent in STEM+C fields. Yosso (2005) termed acts of perseverance by Black and Hispanic women in these hostile and "dismissive" (Varma & Hahn, 2007, p. 366) environments as strength represented through resistance capital. However, research (Bowman, 2022) has demonstrated that universities can also address the negative impact of these adverse psychological dynamics by increasing the number of female instructors in STEM+C classrooms. Taken together, these findings indicate that while structural exclusion has been recognized and investigated it still exists and continues to negatively impact women, and systemic solutions are still necessary.

Black and Hispanic Women in Computing

In addition to systemic gender inequalities, Black and Hispanic women have experienced what researchers (Malcolm et al., 1975; Pierszalowski et al., 2021) have labeled the "double bind" of being both Black or Hispanic and female in science. Known more recently as intersectionality (Crenshaw, 1991), or the multiplicative negative impact at the intersection of two or more marginalized identifies, Black and Hispanic women encounter barriers to STEM+C college completion specific to the combination of their race and gender. Manifestations of structural exclusion of Black and Hispanic women include a lack of representation in the field; difficulty bridging cultural expectations; stereotype threat; lack of high-quality preparation prior to college; high financial need/need to work; unwelcoming campus climate; unconscious bias; racism; microaggressions; and social exclusion resulting in lower retention, persistence, and graduation rates (Crum, 2022; Pierszalowski et al., 2021).

The most commonly noted negative experience for women of color in the literature is that of microaggressions (Chakraverty, 2022; Jaumont-Pascual et al., 2021; Wilkins-Yel et al., 2019). These microaggressions have been categorized under four themes: (1) implicit and explicit messaging of a failure to belong in STEM+C, (2) delegitimization, (3) being ignored, (4) being gendered and racialized (Wilkins-Yel et al., 2019). Research has shown that these actions are perpetrated by faculty, peers, and others in academia and contribute to hostile learning environments in which Black and Hispanic women feel isolated (Chakraverty, 2022; Jaumont-Pascual et al., 2021). Again, while a CCW model would identify the resistance capital associated with Black and Hispanic women's perseverance, enduring these experiences has been found to negatively impact their graduate program experience (Jaumont-Pascual et al., 2021).

Despite these negative experiences, Black and Hispanic women of color continue to pursue STEM+C degrees, albeit at lower rates than their peers (Lord et al., 2015). Research demonstrates that Black and Hispanic women attribute their persistence to various social factors including mentors and families, individual and social strategies, and leveraging cultural capital (Ashford-Hanserd et al., 2017; Jaumont-Pascual et al., 2021; Talley & Ortiz, 2017; Wilkins-Yel et al., 2019).

Community Cultural Wealth and STEM+C

CCW as a theoretical framework has been present in the literature for almost two decades (Yosso, 2005). However, its operationalization in quantitative studies is still in progress (Samuelson & Litzler, 2016). This is not surprising given that Yosso (2005) specifically stated that "these various forms of capital are not mutually exclusive or static but rather are dynamic processes that build on one another as a part of community cultural wealth" (p. 77). This is not to say that CCW is not operationalizable. It is only to suggest that to apply CCW as conceived requires researchers to acknowledge the framework does not lend itself inherently to mutually exclusive constructs but may be more aptly applied with a measure of flexibility, inclusion, and *nepantla*—the ability to live in the in-between (Anzaldua, 1987). That is to say, a mixed-methods approach considering both quantitative and qualitatively supported conceptualizations is an appropriate application of CCW. While definitive parameters and various dimensions of the theory may never be firmly determined, much foundational knowledge has been gleaned by its application.

With regard to aspirational capital, Samuelson and Litzler (2016), who specifically researched engineering students, explained that African American and Hispanic students typically utilize their aspirational capital during their undergraduate program to persist. Students expressed aspirations such as wanting a balanced lifestyle, financial security, a chance to make a difference, and many other motivational factors (Samuelson & Litzler, 2016). In the literature regarding Black and Hispanic women in STEM education it was deduced that informal STEM programs help develop strong aspirational capital for this population (Lane & Id-Deen, 2020).

Linguistic capital was found to be presented in the literature in terms of code-switching. Code-switching is a way to navigate social class across various dimensions (Elkins & Hanke, 2018; Martin & Newton, 2016; McPherson, 2012). While investigating African American women in science majors, McPherson (2012) highlighted the women's need to code-switch between their neighborhood and college cultures. However, most research regarding linguistic capital has focused on race/ethnicity. For example, Zamudio (2015) found that for the Hispanic population in STEM majors, speaking Spanish allowed students to develop social relationships with other Spanish speakers in their college. In this instance, employing linguistic capital also supported the connection to what could be conceived as familial and social capital.

According to Lane and Id-Deen (2020), Black girls who attended STEM programs were highly influenced by their supportive familial capital. For Hispanic women, "mothers provided critical support to sustain STEM interest over time" (Rincón & Rodriguez, 2021). Fernández et al. (2021) discussed how, for students of color in college, familial capital can also include friends on campus who form tight bonds in supporting each other through their STEM studies. Much of the research regarding improving the computing pipeline for Black and Hispanic women considers the need for mentors and community support (Gates et al., 2016; Thiry & Hug, 2014; Whitney et al., 2013).

African Americans in computer science majors have been studied in terms of creating computational communities or using cultural capital to teach computer science in a community to engage students (Lachney, 2017). For Hispanic women in computing, peer support and empowerment in a social context or affinity groups, without the sense of competition, was essential for their success (Gates et al., 2016; Thiry & Hug, 2014). Specifically, for women of color in STEM education, counter-spaces where women provide each other solidarity and

support improve their persistence (Ong et al., 2018). Counter-spaces were used as an opportunity to employ resistant capital.

African American women in STEM majors notably have coped with gendered racism through resistance, which includes speaking up against microaggressions (McPherson, 2017). Rincón and colleagues (2020) described how Hispanics either disengaged from competitive values with each other that only created more forms of oppression and/or negotiated by committing to giving back to their communities through volunteering or getting involved in co-curricular activities. Simply being critically aware of systemic inequalities in STEM education and persisting in the field regardless of the barriers is a form of resistant capital (Denton et al., 2020; Martin & Newton, 2016; Samuelson & Litzler, 2016; Zamudio, 2015).

McPherson (2017) showcased how African American women in STEM specifically face gendered racial microaggressions and stereotyping but have utilized navigational capital to manage these racialized incidents. Pérez Huber (2009) has also identified how Hispanics face various challenges due to racist discourse while navigating their higher education. Thiry and Hug (2014) acknowledged that Hispanic women in the field of computing navigate often difficult academic pathways. Specifically, women in the field of STEM encounter more barriers compared to men (Scott & Martin, 2014). Samuelson and Litzler (2016) attested that African American and Latino students primarily accessed navigational capital when traversing through their engineering programs.

In addition to the six dimensions of CCW proposed by Yosso (2005), researchers (Barrett, 2010; Park et al., 2020; Pérez Huber, 2009; Sanchez et al., 2016) have offered spiritual capital as a form of CCW. Spiritual capital is the use of spirituality and religion as a critical source of strength, resilience, and capital (Park et al., 2020; Pérez Huber, 2009). According to Pérez Huber (2009), spirituality can exist as its own form of capital or can overlap with the other CCW forms of capital. Various studies have showcased how Black and Latino/a individuals' religious involvement fosters their aspirations and are connected to other forms of CCW capital (Barrett, 2010; Park et al., 2020; Sanchez et al., 2016). However, fewer studies have identified how spiritual capital influences Black and Hispanic women's persistence in STEM and particularly in the undergraduate computing majors.

Methods

This pilot mixed-methods study investigates the effects of CCW on the persistence of Black and Hispanic women in the computing workforce pipeline with the aim of illuminating the CCW factors and lived experiences that have influenced Black and Hispanic women's enrollment and persistence in undergraduate computing education. The research team collected quantitative data (via primary survey) and qualitative data (via deidentified interviews) sequentially, independently analyzed the results, and then merged the findings to explore the effects of CCW on Black and Hispanic women's persistence in the computing education and workforce pipeline.

Participants

Fifty-nine participants were recruited through convenience sampling to conduct the pilot study. The research team emailed university faculty in computer science, computer engineering,

and computer information systems to invite students who identified as Black, African American, Hispanic, or Latino/a and who were classified as juniors or seniors to complete the survey via Qualtrics. Twelve participants completed the full survey. Of the 12 survey respondents, four women willingly participated in the follow-up interview (Table 1).

Table 1

Interview Participant Profile Summary

Pseudonym	Age	Race/Ethnicity	Major
Brittany	18–24	Hispanic	Computer Science
Michelle	18–24	Black	Computer
Vanessa	25–29	Hispanic	Computer Information Systems
Bella	25–29	Hispanic	Computer Science

Data Collection

Data were collected using a 14-item, Likert-scale instrument (Ashford-Hanserd, Daniel, K., Garcia, D. M., & Idema, J. L, 2020), which was modified to include two additional items. These 16 items or variables of influence were aligned to the seven CCW dimensions. The 16 Likert-scale questions explored enrollment and persistence in computing majors (e.g., computer science, computer information science, computer engineering). The Likert-scale questions ranged from 1 (*strongly disagree; made me want to change major/program*) to 7 (*strongly agree; strongly made me want to enroll/stay enrolled*). The survey also collected demographic data including date of birth, gender, race/ethnicity, citizen status, parents' highest degree obtained, languages spoken, hometown zip code, program of study, current grade level, postgraduation aspirations, courses completed in middle school, courses completed in high school, participation in additional academic programming, the decision to enroll in their major, and the main reason they remained enrolled in their major. Participants were invited to complete the survey through an email invitation sent to the student's university email address by their program faculty. The survey was administered, and data were collected through Qualtrics at an HSI.

Interviews were solicited through the final survey question: "If you are a Black or Hispanic female, would you like to participate in a follow-on interview to share more about your life experiences in the STEM or computing workforce pipeline?" Those who agreed were contacted using the contact information provided upon consent to participate and invited to schedule a one-on-one interview via Zoom. Counter-life herstory (Ashford-Hanserd, 2016), a method for sharing a retrospective account of one's life experiences, was employed. All interviews were recorded and transcribed verbatim. Timeline interviews (i.e., audio files, handwritten or Microsoft PowerPoint documents), and semi-structured counter-life story interviews (i.e., audio files) were gathered as specific data points for analysis.

Data Analysis

Data analysis for this mixed-methods pilot study included both quantitative and qualitative data. Quantitative data from the 16 Likert-scale questions were analyzed using descriptive statistics (i.e., means) in Statistical Package for the Social Sciences (SPSS) Version 28 to gather survey response rates, timeframes, demographic information, and preliminary data analysis regarding CCW dimensions. We also mapped the relationship between the variables of influence and CCW dimensions. As depicted in Table 2, the matrix was developed to describe the perceived relationship among the 16 variables of influence and CCW dimensions based on theoretical interpretation of these constructs.

Table 2

Relationship Between Variables of Influence and Community Cultural Wealth Dimensions

Variables of Influence	Aspirational	Social	Navigational	Resistant	Familial	Spiritual	Linguistic
My Aspirations or Personal Motivation	x						
My Self Confidence/Self-Efficacy in STEM+C	x		x				
My Personal Faith/Spirituality						X	
Family Support					x		
Peer Support		x	x				
Role Models in STEM+C		x					
Mentor/Mentorship Experiences		x	x				
STEM Academic Program Hosted at Faith-Based Institution		x		x		X	
Participation in a Faith-Based School Before College		x		x		X	
Sense of Belonging in the Program		x	x		x		
Institution or Organization's Commitment to Diversity				x			
Institution's Inclusivity of Multilingual Learners and Diverse Communication Styles							x
My Experiences with Microaggressions at My Institution				x			
My Experiences with Discrimination at My Institution				x			
Negative Gender Stereotypes in STEM+C				x			
Negative Race/Ethnicity Stereotypes in STEM+C				x			

Qualitative data were analyzed using a deductive thematic analysis approach (Braun & Clarke, 2006) to identify emergent themes based on the codebook of CCW components using

NVivo. The researchers adapted Braun and Clarke's (2006) six-step thematic analysis process as follows: (a) read interview scripts for familiarity, (b) create a code book in NVivo by entering the list of codes derived from the interview protocol and research questions, (c) perform deductive coding of interviews by manually organizing participants' quotes under each associated code and then perform inductive open coding by adding new codes as needed, (d) review and refine list of codes, (e) identify high-level themes and manually regroup the codes and the associated quotes under these themes, (f) produce the final report of emergent themes with the associated participants' quotes. The coding results were verified by members of the advisory board and loaded into the NVivo qualitative data analysis software to ease accessibility for comparison and future data analyses.

Data Trustworthiness

We employed data triangulation methods (Brantlinger et al., 2005) and member checking (Creswell, 2014) by emailing participants a copy of the transcripts to obtain their feedback. We were committed to exclude any language that the participants deemed necessary.

Results

The ASCM survey (Ashford-Hanserd et al., 2020) was distributed in March 2022 and received fifty-nine (59) responses (Ashford-Hanserd, S., Moreno, T.D., Kukde, R. D., Hough, T., & Franco Carrera, L., 2026). Nearly ninety-four percent (93.8%) of responses were received within the first 2 weeks of distribution (March 24 to April 7, 2022). Of those who responses, 12 completed the survey and their answers were used for further analysis. This included one (1) Black/African American woman, six (6) Hispanic/Latina women, one (1) Black/African American man, two (2) Hispanic/Latinos men, one (1) nonbinary Black/African American individual, and one (1) biracial Black/African American, Hispanic/Latino man (see Table 3).

Table 3

Participants by Race and Gender

	Gender		
Race	Female	Male	Self-Identified
Hispanic or Latino/a	6	2	0
Black or African American	1	1	1
Multiracial Hispanic/ African American	0	1	0
Total	7	4	1

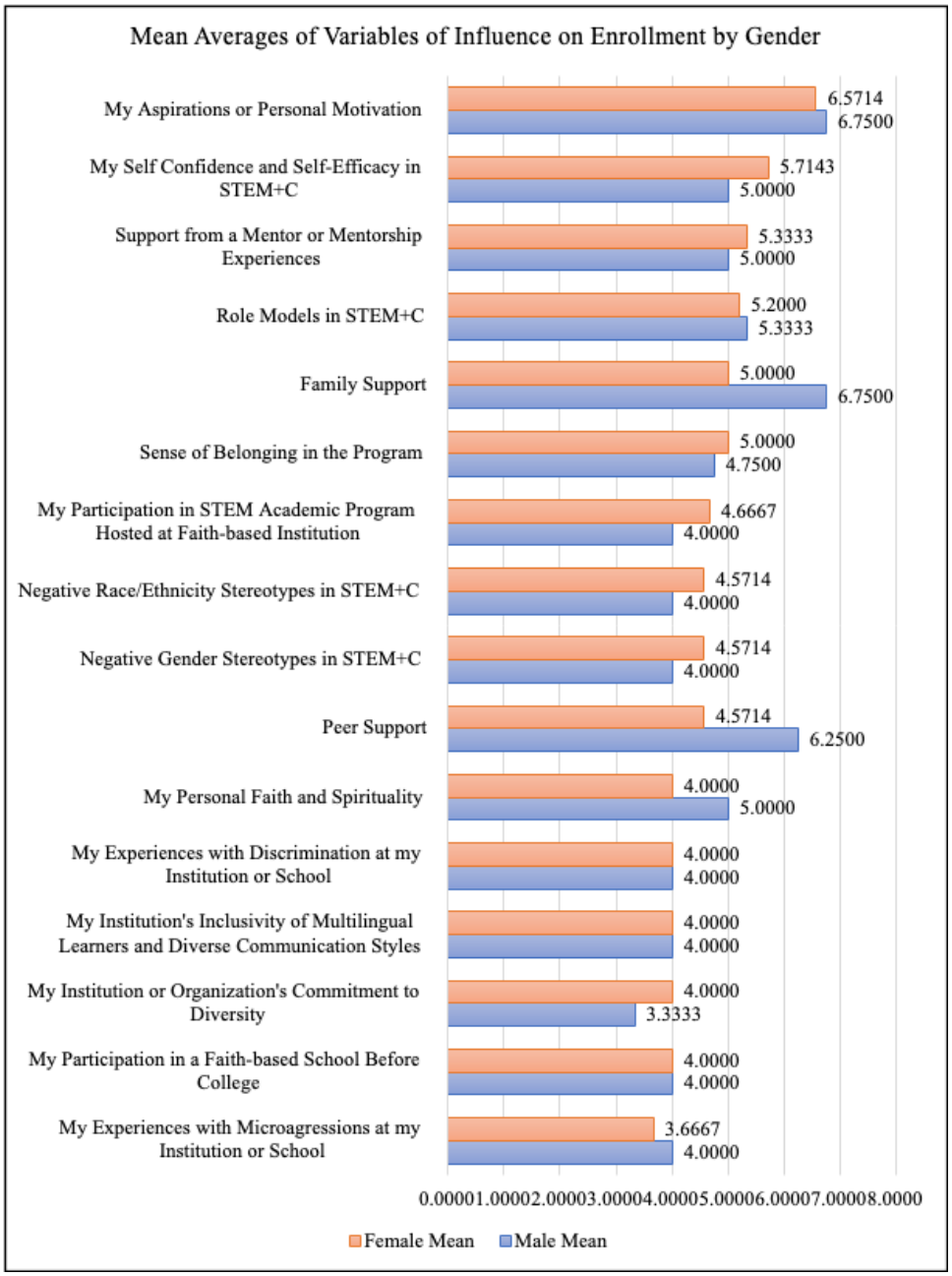
Note. Gender options collected included Female, Male, or Self-Identify.

The influence of different forms of cultural capital was carried out using the Likert-scale means of each variable of interest. In reviewing the forms of capital influencing Black and Hispanic STEM+C enrollment and persistence, differences were noted between female and male responses and between enrollment versus persistence. The top four forms of capital influencing female enrollment were (1) My aspirations or personal motivations ($M = 6.57$), (2) My self-

confidence/self-efficacy in STEM+C (*M* = 5.71), (3) Mentor/mentorship experiences (*M* = 5.33), and (4) Role models in STEM+C (*M* = 5.20). The top four forms of capital influencing male enrollment were (1) My aspirations or personal motivation (*M* = 6.75) and Family support (*M* = 6.75), (2) Peer support (*M* = 6.25), and (3) Role models in STEM+C (*M* = 5.33). The complete list of variables of influence on enrollment by mean average and gender is displayed in Figure 1.

Figure 1

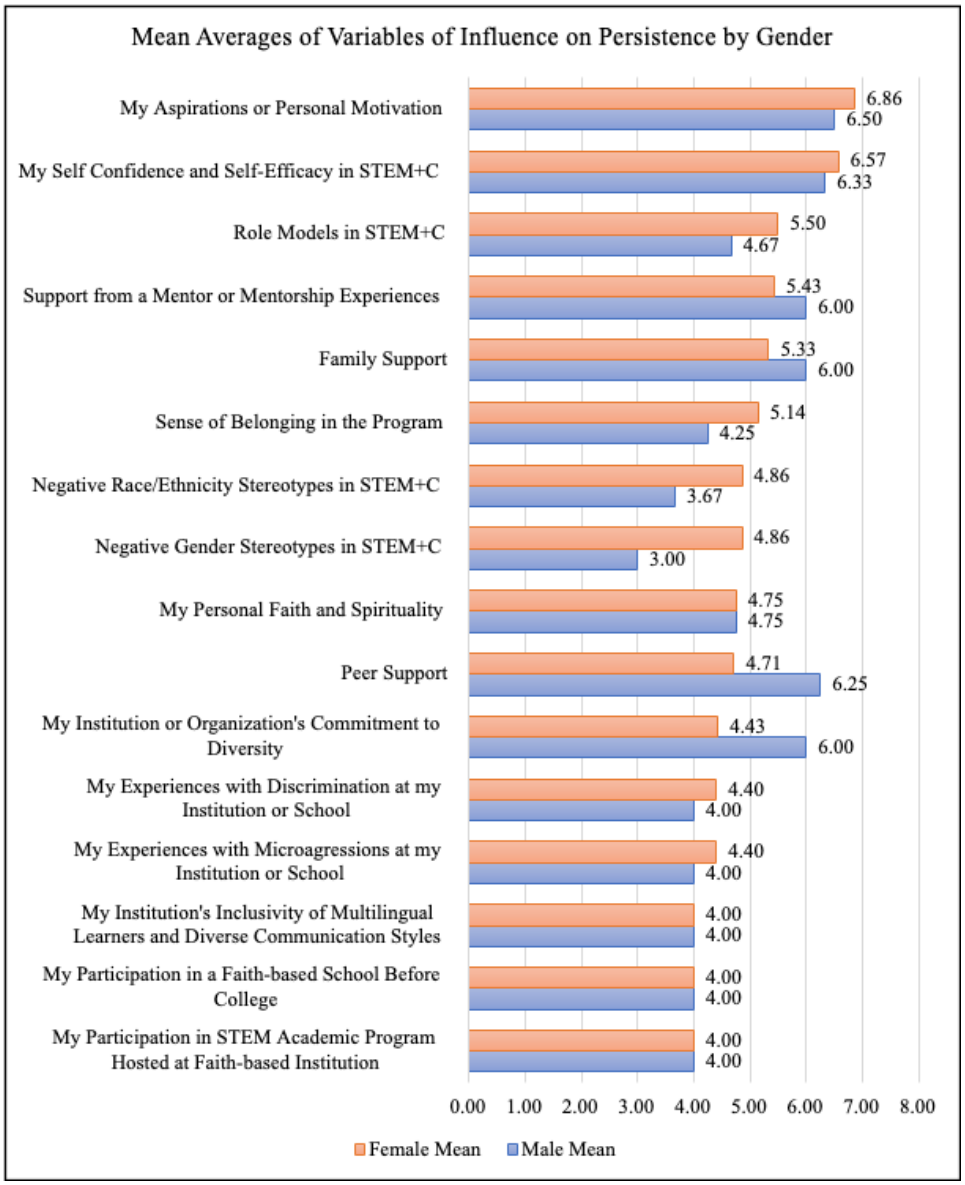
Mean Averages of Variables of Influence on Enrollment by Gender



The top four forms of capital influencing female persistence were (1) My aspirations or personal motivations (M = 6.86), (2) My self-confidence/self-efficacy in STEM+C (M = 6.57), (3) Role models in STEM+C (M = 5.50), and (4) Mentor/mentorship experiences (M = 5.50). The top four forms of capital influencing male persistence were (1) My aspirations or personal motivation (M = 6.50); (2) My self-confidence/self-efficacy in STEM+C (M = 6.33); (3) Peer support (M = 6.25); and (4) Family support (M = 6.00), Mentor/mentorship experience (M = 6.00), and Institution or organization's commitment to diversity (M = 6.00). The complete list of variables of influence on persistence by mean average and gender is displayed in Figure 2.

Figure 2

Mean Averages of Variables of Influence on Persistence by Gender



Findings

In line with the theoretical framework of this study, first-round analysis of the interviews conducted with the Black and Hispanic women demonstrate the overlap of various forms of capital identified by Yosso's (2005) CCW framework present in the participant counter-life herstory interviews. Findings are presented in terms of effect on enrollment and persistence.

Selecting STEM+C

Aspirational (mapped quantitatively as personal motivation and self-efficacy) and familial (mapped as familial and a contextual sense of belonging) capital appeared to influence

Black and Hispanic women's choice to pursue and persist in STEM+C career pathways. These findings substantiate the survey results regarding the importance of aspirational capital. However, unlike the survey results, the interviews also highlighted Black and Hispanic women's use of familial and navigational capital, thus indicating that the qualitative interviews added a level of nuanced understanding to the participants' perceptions and alignment with CCW's premise that CCW assets are not mutually exclusive (Yosso, 2005).

Participant aspirations presented as a desire to gain what they did not currently possess. Potential hardships such as "struggling" and lack of "stability" were seen not as barriers but as motivations. Bella explained what could have been perceived as a barrier as motivation with the following reflection:

> [T]he only reason why I wanted to become a dentist was because my family couldn't afford dental care. And I seen that my mom was struggling, and I couldn't like, get my cavities filled or I couldn't get like, my teeth pulled out because we didn't have money. So I was like, okay, let me focus on science and let me get into dentistry. That's gonna help my family.

Bella highlights not only her aspirations ("I wanted to become a dentist") but use of familial capital ("That's gonna help my family") in the explanation for her decision to "focus on science."

Michelle's explanation was more straightforward in identifying her aspirational capital:

> I just really want to have stability, like with like my career. 'Cause my parents have definitely gone through times where like they like have gotten laid off or like whatever. So, I definitely want like job stability and I definitely, I wanna purchase a house. <laugh> Those are the goals.

Again, Michelle used hardships ("Parents have definitely gone through times where they … have gotten laid off") to illustrate her motivations rather than as a barrier to her pursuit of a career in STEM+C.

However, participants made it clear that their aspirations were not only about financial stability; participants also expressed joy in their self-efficacy in combination with their interests. As summarized by Michelle, "You know, it's like following what you wanna do and, you know, feeling capable in doing that." Vanessa illustrated the importance of self-efficacy through the following statement:

> I guess [the academic award] showed me that that's like, it is something that I'm good at and something that like I enjoy doing, 'cause I feel like a lot of people like do this career for the money purposes, but this is something that like, I actually like enjoy and like doing so I was happy to see that like I guess like my hard work and my talents like did pay off for it.

Brittany noted, "initially I was [majoring in] electrical engineering before switching to computer science. Um, you know, once I just realized I enjoyed it more." Brittany also recognized a level of autonomy in their ability to choose between high-wage career paths. Vanessa noted her desire and ability to pursue a profession she enjoyed because it supported creativity. She stated:

> I was again like surprised by how well I understood material and just like how easy it came back to me and kind of just like gave me that sense of like I built something and I can do it. And I'm good at this. So kind of just kind of like reignited, I guess, the, the need to create software or developing.

She continued:

> I've always been an artist, um, and been into creating art, uh, and doing engineering felt like, you know, 'cause you're learning how to like build things or create things or make things. So it, it felt like a good way to combine this like interest in kind of like getting my elbows dirty with, you know, actually having the tools to create something.

In this way it appears that aspiration capital and navigation capital may be entwined—a participant might think, "I learned this about myself (self-efficacy); therefore, I chose to move in this direction (navigation)."

Enrollment

While aspirational, familial, and navigational capital appeared to support participants' desire to pursue STEM+C degrees, their enrollment appears to be supported by social, navigational, and resistant capital. It is important to note that participants did not explicitly identify what drove their decisions and what actions they took to pursue careers in STEM+C in terms of capital. Rather, participants shared reflections about what at times felt like luck, using such terms as "found" and "fell" when, in actuality, it was their astute observations that aided in their navigation into the unknown. Bella recalled:

> Yeah, so I think maybe that springboard was when I actually found computer science and coding. So that was when I was about, I don't know. I think I was like, my second year in college had already studied biology [and] was planning on going to dental school but found that it was just really expensive and I just happened to fall upon computing and computer science, 'cause my boyfriend was in like the startup world or something. So I'm like, oh I can do this. So I tried it and I found out that I could do it and I enjoyed it and I was really good at solving problems. And then from there I just like decided to change my major and just focus on that solely.

Bella demonstrated that her navigational capital assisted her in switching majors from biology to computer science, which was informed by her social capital ("'cause my boyfriend was in like the startup world or something.") However, not all participants had the additional support of social capital, as Brittany captured when explaining her decision to select computer science as her field of study:

> I think I just had a big lack of understanding of the difference between those three majors [MIS, CIS, and CS] and I felt like no one really like explained it to me the difference. … And so I did research on my own and I figured it out, oh, like this is what I wanted do.

Alternatively, Vanessa attributed her ability to navigate her choice over time. She explained:

> I felt smart and capable like, and I want like, so yeah, I think once I started getting older and like in maybe that range, um, like in my early 20s I knew I felt smart and capable and I was like, well maybe I could do something that, that proves that.

In this instance, Vanessa's decision to pursue a computer science degree stemmed from both her confidence in her abilities and her desire to "prove" to others that she was "capable," or, a form of resistant capital.

Persistence

Persistence in the participants' majors appeared primarily to be undergirded by resistance capital and further supported by social and familial capital. Bella shared:

> But I also kinda, I don't know. I don't know if it's thrive, the word is thrive, but I like to sit in the front of the class and make sure that I'm seen or when I present or something, I make sure that, you know, I'm there, like in my suit jacket or like, and I look the part and I'm making sure that everyone is paying attention, that I'm also there.

Bella's statement, "I look the part and I'm making sure everyone is paying attention, that I'm also there," succinctly illustrates the strength she is drawing from her knowledge that she is subverting the systemic, hegemonic narrative that STEM+C is for males only. Further, she uses this knowledge to drive her persistence. She went on to explain:

> I guess in computer science classes, like women are always seen, or maybe I feel this way are always seen, like, not as smart or not as skilled. So, when I said I don't wanna brag, I dunno. <laugh> Maybe I just wanted them to like to continue doubting me. So, I can prove them wrong somehow. Because that really like drives me when someone's like, no, you can't do that. Or like, I don't know, but yeah, so maybe I just wanted to like, kind of prove them wrong, but I didn't wanna be too showy about it.

Bella's desire not to be "too showy about it" may be an acknowledgement that she felt a need to build community to be able to be successful and persist in STEM+C. Alternatively, Brittany shared:

> I think that from the first year to the second year and third year were very similar. It was just about going to school and learn[ing] new things and having labs with other people. I think the most important year will be the fourth year, which I called the advancement step, where I met actually people that were very supportive of it. People that were actually specialized in their field, they had experience. And that I knew they knew a lot of things about it. I do remember two teachers that one of them was, he knew that I had potential and he asked me to actually try to participate in class and to be more outspoken. And the second teacher I had was a teacher that was actually concerned with every student. He kept up on whether you were doing homework, if you were doing well and things like that.

Brittany noted teaching assistants who supported and believed in her. This helped build her confidence and persistence. However, social capital does not need to be formal or long-term. Bella noted she navigated the identification of the selection of her internship through a casual interaction:

> I feel like somebody in that club had an internship at Charles Schwab and then I remember, I don't know why I remember that. And I was like, oh, let me look there. And then like I applied there and like other places as well, but they just responded back the quickest.

Again, this example illustrates both social capital (participation in a club) and navigational capital ("let me look there"... "they just responded back the quickest").

Participants continued to demonstrate navigational capital as a means to persist against a variety of obstacles. For example, Vanessa shared:

> I think the biggest challenge is being an adult before going back to school and then fitting in college with also having a life and working. Whereas I think, a lot of students, not that they don't also have struggles when they're younger right out of high school, but I think their just lifestyle accommodates it better because their like school was their life in high school. And then they're just kind of naturally, you know, continuing that story with college. So, I guess I would just say that that the biggest challenge has been being an adult and kind of going through different relationships like beginning and ending and jobs beginning and ending and holding down like a household, I guess <laugh>, and kind of managing that with school, I would just say has been the biggest challenge overall.

Vanessa was an adult learner and had to navigate the challenge of being older than the typical college student. She shared that her struggles were different from those of her peers. While her peers were dealing with college-related issues, she was dealing with a more mature lifestyle. Much research has shown how Black and Hispanic women in STEM+C face many racialized incidents but then utilize navigational and resistant capital to overcome them (McPherson, 2017; Pérez & Hug, 2014; Thiry & Hug, 2014). However, in this example, we see this participant navigating structures due to ageism and yet, persisting through them.

A final motivation to persist was drawn from familial capital. Bella, after describing the struggles her family faced being brought up by a single mother stated respectfully that her "[mother's] need to have more and give her kids more is what pushes me." Bella showed how her mother's continued desire to push her family forward motivated her to persist and succeed.

Discussion

The purpose of this study was to investigate which CCW factors influence the enrollment and persistence of Black and Hispanic undergraduate women of color in comparison to their male counterparts in the STEM+C workforce pipeline at an HSI in Texas. The result of the present study supports the hypothesis of the relationship between the variables of influence and CCW dimensions. There are three key findings to the present research. First, CCW dimensions that influence the enrollment and persistence of women of color are distinctly different than dimensions that influence the enrollment and persistence of men in the STEM+C workforce pipeline at the HSI. Second, CCW dimensions that influence the enrollment of women of color are prioritized differently than dimensions that influence persistence. Third, CCW dimensions are present as overlapping constructs rather than discrete variables.

These findings are in line with previous research and add an additional level of detail to guide future research. As previous research has noted over decades (Bowman et al., 2022; Buzzetto-More et al., 2010; Lord et al., 2015), there is a noticeable difference between female and male enrollment, completion, and pursuit of STEM+C career paths. This study complements these findings by highlighting that these differences extend to how women and men enroll and persist in STEM+C fields. Further, these findings highlight the opportunity to further explore the differences within the pipeline itself from selection, to enrollment, to persistence and completion

illuminated in the qualitative portion of the study. Most notably, while the literature has tended to investigate factors of CCW as discrete variables (Barrett, 2010; Denton et al., 2020; Fernández et al., 2021; Lane & Id-Deen, 2020; Martin & Newton, 2016; McPherson, 2017; Park et al., 2020; Pérez Huber, 2009; Samuelson & Litlzer, 2016; Sanchez et al., 2016; Zamudio, 2015), this study highlights the possibility of greater fealty to the original conceptualization and application of CCW may provide for a greater depth and more nuanced understanding of the experiences of women of color pursuing STEM+C career paths.

These findings strongly imply that the lived experiences of women of color pursuing STEM+C career paths are distinctly different than their male counterparts'. Using the strength-based framework of CCuW offered by Yosso (2005) provides a foundation for better understanding of their multifaceted stories. While women and men may draw from similar sources of motivation (or aspirational capital) the extent to which females rely on their own self-efficacy and confidence is greater than their male counterparts' both prior to and during their academic pursuits. While men's reliance on peer support increases in aiding their persistence, women note an increase in negative factors such as experiences of microaggressions and discrimination (or resistant capital) in aiding their persistence.

However, what is most evident in this study is the lack of mutual exclusivity of factors of CCW on women's enrollment and persistence. As hypothesized, much like the intersecting nature of women of color's experience in STEM+C, the application of the factors of CCW are also entwined. The female participants were unable to discuss their aspirations without noting their motivation (familial capital). While their enrollment was guided by navigational capital their persistence was augmented by peer support (social capital). Their persistence, though, appeared to stem from an internal motivation or drive grounded in a desire to accomplish what they knew few women had (resistant capital) and accomplished this through relationships (social capital) and their ability to move through choices, decisions, and processes (navigational capital).

Limitations

As a pilot study providing initial findings, this study is limited by sample size and is not generalizable to a broader population. It is possible that increasing the sample size would affect the current findings. Further, the sample is limited to one HSI in Texas and a broader sample may result in different findings. Finally, limited research has been conducted using CCW. Further advances in its use may influence the findings and subsequent interpretations of this study.

Implications

Future Study

Preliminary findings from the current pilot data indicate that application of a modified CCW theoretical framework assist the identification of emergent themes supporting the enrollment and persistence of Hispanic and Black women pursuing undergraduate computing education. Further, as postulated by Yosso (2005), the forms of CCW do not seem to be mutually exclusive variables of influence. Instead, it appears various forms of CCW are emerging entwined. This is of significance when considering future quantitative analysis. While theoretically and qualitatively unconcerning, lack of mutual exclusivity could present itself as

multi-collinearity during quantitative analysis. Further, to address this potential multi-collinearity through traditional quantitative treatments, it is possible that a level of detail could be lost. Therefore, it is recommended that future quantitative analysis take into consideration how dimensions of CCW may present in quantitative analysis.

Future Practice

Preliminary findings from the current data also indicate that the extent to which Hispanic and Black women draw upon dimensions of CCW may not be static; it appears that dimensions of CCW drawn upon by Black and Hispanic women may shift over time during their pursuit of computing education. This is important for practitioners to understand so that programs, services, and interventions are timely and tailored appropriately to change and grow as students change and grow. For example, preliminary findings indicate that Black and Hispanic women pursuing computing education find mentors important in pursuing STEM education pathways (pre-college enrollment) and role models more important in persisting in STEM education pathways (during college enrollment). Minor differentiations such as this can inform major decisions such as funding, resources, and policies with greater confidence based on research-informed decisions.

Future Policy

Preliminary findings of this study are in line with previous research (Walter & Wade, 2024) regarding the importance of mentors and role models on students' educational success whether success is measured as educational pursuits, persistence, or completion. Within the framework of CCW these relationships would be categorized as social capital. Peer groups, also found to support persistence in this study, are also classified as social capital. Our understanding of the importance of relationships precedes Bourdieu (1986). It is therefore recommended that educational policies focus on the importance of providing diverse environments through students, faculty, and staff hires; programs that support the retention and growth of marginalized faculty; and formal recognition of mentoring activities provided by faculty.

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